PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Commissioner
US Department of Commerce
United States Patent and Trademark Office, PCT
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Arlington, VA 22202
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in its capacity as elected Office

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International application No. PCT/AU00/00953	**Applicant's or agent's file reference** 475709C
International filing date (day/month/year) 11 August 2000 (11.08.00)	**Priority date** (day/month/year) 13 August 1999 (13.08.99)
Applicant SCOTT, Trevor, William et al	

1. The designated Office is hereby notified of its election made:

[X] in the demand filed with the International Preliminary Examining Authority on:

09 February 2001 (09.02.01)

[ ] in a notice effecting later election filed with the International Bureau on:

2. The election [X] was

[ ] was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Claudio Borton
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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00953

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A23C 9/14, A23D 9/02, A23K 1/00, 1/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: A23C, A23D, A23K and keywords

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPIDS and keywords

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3925560 A (SCOTT et al) 9 December 1975 Column 2 lines 27-53 and column 7 example 3	1-21
X	US 3966998 A (RAWLINGS et al) 29 June 1976 Abstract and column 10 example 1	1-21
X	US 4073960 A (SCOTT et al) 14 February 1978 Column 2 lines 7-24 and 36-56, claims 1-6	1-21

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 October 2000	16 OCT 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer ANDREW ACHILLEOS Telephone No : (02) 6283 2280

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00953

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4216234 A (RAWLINGS et al) 5 August 1980 Abstract, column7 lines 1-42	1,2 and 17-21
X	US 5143737 A (RICHARDSON, Thomas) 1 September 1992 Abstract, column 11 example 1	1,2 and 17-21
X	US 5670191 A (CUMMINGS et al) 23 September 1997 Column 2 lines 15-25, column 7 example II	1,2 and 17-21
X	US 5932257 A (WRIGHT et al) 3 August 1999 Column 2 line 57 to column 3 line 15	1,2 and 17-21

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00953

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4 216 234	AU	21283/77	CA	1086127	GB	1570852
		JP	52-112573				
US	5 143 737	AU	65425/90	WO	91/05482		
US	5 670 191	AU	69699/96	BR	9610710	CA	2229560
		EP	871373	WO	97/11611		
US	5 932 257	AU	30862/97	BR	9709882	CA	2208392
		EP	906031	WO	97/49297		

END OF ANNEX

Claims

1. A method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally.

2. The method according to claim 1, wherein about 75 to about 90% of protected lipid is capable of passing undegraded through the rumen.

3. A method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions of fatty acids, wherein said method comprises feeding to the ruminant livestock protected lipid having said desired proportions of fatty acids, wherein said protected lipid is produced by the emulsification of lipid with protein in the presence of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion.

4. The method according to claim 3, wherein the protected lipid is produced by the reaction with between about 2.0 grams and about 2.6 grams of formaldehyde per 100 grams crude portion.

5. The method according to any one of claims 1 to 4, wherein the desired proportions and/or types of fatty acids are: C18:1 cis (25-45%w/w); C18:2 (4-15%w/w), including conjugated isomers (0.05 to 5%w/w), C18:3 (1-8%w/w); C20:5 and C22:6 omega fatty acid (1-3%w/w).

6. The method according to any one of claims 1 to 4, wherein the desired proportions and/or types of fatty acids are: C16:0 cis (25-35%w/w), C18:0 (20-30%w/w) and C18:1 (20-25%w/w).

7. The method according to any one of claims 1 to 6, wherein the source of lipid is selected from the group consisting of: soybean, cotton, lupin, peanut, sunflower, canola, sesame seed, copra and coconut, palm kernels, linseed, casein, butterfat, lard, fish oils, tung oil, tallow, and oil lipid products derived from oil sources by chemical/biological processes, or a combination thereof.

8. The method according to claim 7, wherein the source of oil lipid product is conjugated linoleic acid.

9. The method according to claim 7, wherein the source of lipid is derived from oil sources by chemical/biological processes, or a combination thereof.

10. The method according to any one of claims 1 to 9, wherein the source of lipid is yellow grease.

11. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein available for digestion post-ruminally.

12. The method according to any one of claims 1 to 11, further comprising simultaneously feeding to the ruminant livestock protected carbohydrate such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

13. The method according to any one of claims 1 to 11, further comprising simultaneously feeding to the ruminant livestock: (i) protected protein, such that such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally

14. A method according to any one of claims 11-13, wherein the source of protein and/or carbohydrate is plant and includes any one of, or a combination of barley, corn, oats, wheat, rice, millet, triticale, rye, and sorghum, soybean, cotton, lupin, peanut, sunflower, canola, sesame seed, copra and coconut, palm kernels and linseed.

15. The method according to any one of claims 1 to 14, further comprising, feeding to the ruminant livestock any other source of processed or unprocessed feedstuff.

16. The method according to any one of claims 13 to 15, wherein the protected carbohydrate, protected protein and/or protected lipid is included in the ration at about 10-45% during the lactation phase.

17. Milk fat obtained from a ruminant fed according to the method of any one of claims 1 to 16.

18. The milk fat of claim 17, wherein said milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

19. The milk fat of claim 17, wherein said milk fat is comprised of hard fats.

20. The milk fat of any one of claims 17 to 19, wherein said milk fat is used in the production of milk based products.

21. The milk fat of any one of claims 17 to 20, wherein said milk based products include: milk, butter, cheese, yoghurt, chocolate or infant formula.

AMENDED CLAIMS

[received by the International Bureau on 15 December 2000 (15.12.00); original claims 1 – 10 amended; other claims unchanged (3 pages)]

1. A method for altering the fatty acid profile of milk from female ruminant livestock to comprise at least one of the following types and proportions of fatty acids in said milk: C18:1 *cis* (25-45%w/w); C18:2 (4-15%w/w); C18:3 (1-8%w/w); C20:5 and C22:6 omega fatty acid (1-3%w/w), or a combination thereof, wherein said method comprises feeding to the female ruminant livestock, protected lipid such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

2. The method of claim 1, wherein said fatty acid profile comprises at least one of: C18:1 *cis* (30-45%w/w); C18:2 (6-10%w/w); C18:3 (2-4%w/w); C20:5 and C22:6 omega fatty acid (1-2%w/w), or a combination thereof.

3. The method of claim 1 or 2, wherein said C18:2 further includes conjugated isomers (0.5 to 5%w/w).

4. A method for altering the fatty acid profile of milk from female ruminant livestock to have at least one of the following types and/or proportions of fatty acids in said milk: C16:0 *cis* (25-35%w/w), C18:0 (20-30%w/w) and C18:1 (20-25%w/w), wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions and/or types of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

5. The method of claim 4, wherein said fatty acid profile comprises at least one of: C16:0 *cis* (28-35%w/w), C18:0 (25-30%w/w) and C18:1 (22-25%w/w), or a combination thereof.

6. The method according to any one of claims 1-5, wherein about 75 to about 90% of protected lipid is capable of passing undegraded through the rumen.

7. The method according to any one of claims 1-6, wherein the protected lipid is produced by the reaction with between about 2.0 grams and about 2.6 grams of formaldehyde per 100 grams crude portion.

8. The method according to any one of claims 1 to 7, wherein the source of lipid is selected from the group consisting of: soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels, linseed, casein, butterfat, yellow grease, lard, fish oils, tung oil, tallow, and oil lipid products derived from oil sources by chemical/biological processes, or a combination thereof.

9. The method according to claim 8, wherein the source of oil lipid product is conjugated linoleic acid or chemical forms thereof.

10. The method according to claim 9, wherein the source of lipid is derived by chemical/biological processes, or a combination thereof.

11. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein available for digestion post-ruminally.

12. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected carbohydrate such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

13. The method according to any one of claims 1 to 10 further comprising simultaneously feeding to the ruminant livestock: (i) protected protein, such that such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

14. A method according to any one of claims 11-13, wherein the source of protein and/or carbohydrate is plant and includes any one of, or a combination of barley, corn, oats, wheat, rice, millet, triticale, rye, and sorghum, soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels and linseed.

15. The method according to any one of claims 1 to 14, further comprising, feeding to the ruminant livestock any other source of processed or unprocessed feedstuff.

16. The method according to any one of claims 13 to 15, wherein the protected carbohydrate, protected protein and/or protected lipid is included in the ration at about 10-45% during the lactation phase.

17. Milk fat obtained from a ruminant fed according to the method of any one of claims 1 to 16.

18. The milk fat of claim 17, wherein said milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

19. The milk fat of claim 18, wherein said milk fat is comprised of hard fats.

20. The milk fat of any one of claims 17 to 19, wherein said milk fat is used in the production of milk based products.

21. The milk fat of any one of claims 17 to 20, wherein said milk based products include: milk, butter, cheese, yoghurt, chocolate or infant formula.

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— *With international search report.*
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

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(54) Title: FEED SUPPLEMENT FOR ALTERING MILK FAT PROFILE

(57) Abstract: The present invention provides a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions of fatty acids, such that about 60 to about 90 % of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90 % of said protected lipid available for digestion post-ruminally.

Feed Supplement for Altering Milk Fat Profile

Technical Field

The present invention relates to feeding techniques for designing the nutritional and physico-chemical properties of milk fat derived from ruminants. In particular, it describes feed supplements which produce milk from ruminants having a desired fatty acid composition, and which is useful in producing products with a range of melting profiles.

Background Art

In recent times, the specifications of the ideal milk fat from a nutritional and physico-chemical view point have changed dramatically. For example, C18 *cis* monounsaturated fatty acids (oleic acid) have been shown to lower the cholesterol content of human low density lipoproteins (LDL) (Noakes *et al.*, 1996). In contrast, the C18 *trans* monounsaturated fatty acid (elaidic acid) will increase the cholesterol content of LDL in humans (Noakes *et al.*, 1996). In addition, the role of n-3 fatty acids in infant nutrition and in particular their importance in neural development and vision has been recently recognised (Simapoulos, 1999).

During the past three decades a range of feed supplements have been developed with the aim of manipulating the fatty acid composition of milk fat. These techniques include feeding of full fat rape seed and soybean supplements, heat treated/jet sploded oil seeds, calcium salts of long chain fatty acids, prilled or pelleted fats and butyl soyamide esters. However, there is an enormous variation in the responses observed (Palmquist, *et al.*, 1993), and it can be concluded that these approaches do not provide a reliable and consistent feed supplement to alter the nutritional and physico-chemical properties of milk fat.

Therefore, the challenge is to design feed supplements that produce milk fat containing a fatty acid composition appropriate for either soft or hard fats. For example, soft fats would be characterised by:

* a reduction in the proportions of saturated acids in particular myristic and palmitic, as these two acids significantly elevate human LDL cholesterol and also contribute to "hardness" of milk fat
* an increase in C18 *cis* mono-unsaturated (oleic) without increasing C18 *trans* mono-unsaturated (elaidic);
* an increase in C18 di-unsaturated (C18:2), including conjugated isomers;

* an increase in C20 and C22 omega fatty acids, that is, C20:5 and C22:6 respectively; and
* an increase in C18 tri-unsaturated (C18:3).

Conversely, harder milk fats are often characterised by:

* high proportions of saturated fats; and
* increases in C16:0 and C18:0.

Therefore, in accordance with the present invention, by altering the amount and/or type of protected lipid fed, it is possible to produce ruminant milk products with a wide spectrum of physical characteristics. Consequently, the present invention provides a way forward to reduce or eliminate the need for expensive fractional crystallisation and enzymatic inter-esterification procedures that are currently being used to improve the physical and nutritional properties of milk fat. In general, the present invention indicates alters the fatty acid profile of ruminant milk fat via the use of feed supplements in which the constituent triacylglycerols are protected from ruminal biohydrogenation

Accordingly, the present invention describes the use of nutritional materials that are protected against rumen degradation and provides a feed supplement which produces milk fat with the desired specifications, that is, a milk fat having either a "soft" or "hard" fatty acid profile.

Object of the Invention

An object of the invention is to provide a method for altering the fatty acid profile of milk from ruminant livestock, and in doing so obtain milk fat comprising desired proportions and/or types of fatty acids.

Disclosure of the Invention

According to a first embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method comprises feeding to the female ruminant livestock protected lipid having said desired proportions and/or types of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally.

According to a second embodiment of the invention there is provided a protected lipid, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said protected lipid is such that about 60 to about 90% of said protected lipid is capable of passing through the rumen

of ruminant livestock undigested, leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally.

According to a third embodiment of the invention there is provided use of a protected lipid, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said protected lipid is such that about 60 to about 90% of said protected lipid is capable of passing through the rumen of ruminant livestock undigested, leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally.

It is preferred that about 65 to about 90% of protected lipids are capable of passing undegraded through the rumen. More preferably, about 70 to about 90% of protected lipids are capable of passing undegraded through the rumen. Even more preferably, about 72 to about 90% of protected lipids are capable of passing undegraded through the rumen. Yet still more preferably, about 75 to about 90% of protected lipids are capable of passing undegraded through the rumen.

Typically, the protected lipid is protected from ruminal biohydrogenation by encapsulation in a matrix of aldehyde-treated protein.

According to a fourth embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method comprises feeding to the female ruminant livestock, protected lipid having said desired proportions and/or types of fatty acids, wherein said protected is lipid produced by the emulsification of lipid with protein in the presence of between about 1.5 grams to about 3.0 grams of formaldehyde per 100 grams crude portion.

According to a fifth embodiment of the invention there is provided a protected lipid having desired proportions and/or types of fatty acids, when used in altering the fatty acid profile of milk from female ruminant livestock to have said desired proportions and/or types of fatty acids, wherein said protected is lipid produced by the emulsification of lipid with protein in the presence of between about 1.5 grams to about 3.0 grams of formaldehyde per 100 grams crude portion.

According to a sixth embodiment of the invention there is provided use of a protected lipid having desired proportions and/or types of fatty acids, in the preparation of feed for altering the fatty acid profile of milk from female ruminant livestock to have said desired proportions and/or types of fatty acids, wherein said protected lipid is produced by the emulsification of lipid with protein in the presence of between about 1.0 grams to about 3.5 grams of formaldehyde per 100 grams crude portion.

It is preferred that the protected lipid is produced by the emulsification of lipid with protein in the presence of between about 1.75 grams to about 3.0 grams of formaldehyde per 100 grams crude portion. Even more preferably, about 2.0 grams to about 3.0 grams of formaldehyde per 100 grams crude portion. Still more preferably, about 2.0 grams to about 2.8 grams of formaldehyde per 100 grams crude portion. Yet still more preferably, about 2.0 grams to 2.6 grams of formaldehyde per 100 grams crude portion.

Preferably, the protected lipid fed in accordance with any one of the first through to sixth embodiments of the invention does not constitute the entire ration, but may be fed together with any other source of processed or unprocessed feedstuff.

Typically, the ruminant livestock fed the protected lipid in accordance with the present invention are selected from the group consisting of: cattle, sheep, goats and buffalo.

Typically, the term "fatty acid profile" describes the particular fatty acid constituents of milk obtained from female ruminant livestock fed protected lipid comprising the particular fatty acid constituents to obtain the desired fatty acid profile.

In one aspect, a preferred fatty acid profile may reflect milk fat containing a high proportion of soft fats. Typically, such a softer fatty acid profile is a consequence of a milk fat containing less saturated and more unsaturated fatty acids (desired proportions of fatty acids). More typically, these fats are characterised by any one of the following: reduction in the proportions of saturated acids in particular myristic and palmitic, as these two acids significantly elevate human LDL cholesterol and also contribute to the "hardness" of milk fat; an increase in C18 *cis* mono-unsaturated (oleic) fatty acids without increasing C18 *trans* mono-unsaturated (elaidic) fatty acids; an increase in C18 di-unsaturated (C18:2) fatty acid, including conjugated forms of linoleic acid; an increase in C18 tri-unsaturated (C18:3) fatty acid; and/or an increase in C20 and C22 omega unsaturated fatty acids, such as, C20:5 and/or C22:6.

A milk fat reflecting a softer fatty acid profile may typically be produced by feeding female ruminant livestock a protected lipid source containing C18 monounsaturated or polyunsaturated fats, or lipids high in C20 or C22 polyunsaturated fatty acids, such as C22:5 and/or C22:6 fatty acids. More typically, the protected lipid source is a oleyl, linoleyl or linolenyl oil containing oil seed.

Typically, the protected lipid source fed to obtain such a softer milk fatty acid profile is selected from the group consisting of plant derived materials including canola oilseed, soybean oilseed, sunflower oilseed, linseed (flax) oilseed, sesame oilseed, grape

oilseed, olive oilseed, safflower oilseed, groundnut oilseed, oils derived from these seeds and oil by products (ie, acid oil or conjugated linoleic acid) produced during refining/hydrogenation processes, marine sources, such as fish oils or mixtures thereof, and oils produced by either chemical, microbiological or biotechnology procedures and alkali isomerisation techniques.

In a preferred aspect, the present invention provides a method for producing softer milk fat which comprises the feeding of canola/soybean oilseed supplement in ratios of about 7:3 (w/w) protected from ruminal degradation. Still more preferably, the present invention provides a method for producing softer milk fat which comprises the feeding of canola/soybean oilseed supplement in ratios of about 7:3 (w/w), soybean oilseed/linseed of about 7:3 (w/w) and soybean oilseed/Hioleic sunflower oilseed of about 7:3,(w/w) and soybean oilseed/fishoil of about 7:3 (w/w), wherein these-lipid sources are protected from ruminal degradation.

Typically, the protected lipid as fed, and as a consequence, the fatty acid profile of milk so produced, comprises the following proportions of fatty acids: C18:1 cis (25-45%w/w), C18:2 (4-15%w/w) and C18:3 (1-8%w/w). Still more typically, the protected lipid as fed comprises the following proportions of fatty acids: C18:1 cis (30-40%w/w), C18:2 (6-10%w/w), including conjugated isomers (0.5 to 5%), C18:3 (1-4%w/w) and C20 and C22 omega fatty acids, C20:5 and C22:6, (1-2%w/w).

In another aspect of the invention, the desired proportions and/or types of fatty acids in the altered fatty acid profile of the milk reflect a milk fat having a harder fatty acid profile, wherein the harder fatty acid profile is a consequence of a milk fat comprising more saturated and less unsaturated fatty acids, which is produced by feeding female ruminant livestock protected lipid comprising more saturated and less unsaturated fatty acids. Typically, the protected lipid source fed to obtain a harder milk fatty acid profile is high in hydrogenated fats. Even more typically, such fats are characterised by: high proportions of saturated fats and increases in the relative proportions C16:0 and C18:0 fatty acids.

Typically, the protected lipid source fed to obtain a harder milk fatty acid profile is selected from the group consisting of: cotton oilseed, palm oilseed, tallow, lard and sources derived from hydrogenated or partially hydrogenated processes or produced by either chemical, microbiological and biotechnology procedures or mixtures thereof; or other naturally occurring sources of oils/oilseeds that contain inhibitors of the desaturase enzyme systems which operate in ruminant tissues, wherein examples of these inhibitors include cyclopropenoids such as sterculate.

In a preferred aspect, the present invention provides a method for producing hard milk fat containing more C16:0 and C18:0 saturated and less unsaturated fatty acids. Such a profile arises from the feeding of cotton oilseed supplement or cotton oilseed and palm oilseed in ratios of about 8:2 (w/w), but more preferably, 4:2 (w/w), protected from ruminal degradation.

Typically, the protected lipid as fed, and as a consequence, the fatty acid profile of milk so produced, comprises the following proportions of fatty acids: 25-35%w/w C16:0, 20-30%w/w C18:0 and 20-25%w/w C18:1. Still more typically, 28-35%w/w C16:0, 25-30%w/w C18:0 and 22-25%w/w C18:1. Yet still more typically, 30-35%w/w C16:0 and 25-30% C18:0%w/w.

In general, the protected lipid is as described in Australian Patent Nos. 450 530 and 659 557, the disclosures of which are incorporated herein by reference.

According to a seventh embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method is in accordance with the first or fourth embodiments of the invention, and wherein said method further comprises simultaneously feeding to the female ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally.

According to an eighth embodiment of the invention there is provided protected lipid in accordance with the second or fifth embodiments of the invention, further comprising protected protein, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally.

According to a ninth embodiment of the invention there is provided use of a protected lipid in accordance with the third or sixth embodiments of the invention, further comprising protected protein, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally.

More typically, about 65 to about 80% of protected protein is capable of passing undegraded through the rumen. Even more typically, about 70 to about 80% of protected protein is capable of passing undegraded through the rumen. Still more typically, about 72 to about 80% of protected protein is capable of passing undegraded through the rumen. Yet still more typically, about 75 to about 80% of protected protein is capable of passing undegraded through the rumen.

According to a tenth embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method is in accordance with the first or fourth embodiments of the invention, and wherein said method further comprises simultaneously feeding to the female ruminant livestock protected protein, wherein said protected protein is produced by the reaction with between about 0.05g and about 1.0g of formaldehyde per 100g crude protein.

According to an eleventh embodiment of the invention there is provided protected lipid in accordance with the second or fifth embodiments of the invention, further comprising protected protein, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said protected protein is produced by the reaction with between about 0.05g and about 1.0g of formaldehyde per 100g crude protein.

According to a twelfth embodiment of the invention there is provided use of protected lipid in accordance with the third or sixth embodiments of the invention, further comprising protected protein, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said protected protein is produced by the reaction with between about 0.05g and about 1.0g of formaldehyde per 100g crude protein.

Typically, the protected protein is produced by the reaction with between about 0.1g and about 1.0g of formaldehyde per 100g crude protein. More typically, the protected protein is produced by the reaction with between about 0.15g and about 1.0g of formaldehyde per 100g crude protein. Even more typically, the protected protein is produced by the reaction with between about 0.2g and about 1.0g of formaldehyde per 100g crude protein. Still more typically, the protected protein is produced by the reaction with between about 0.2g and about 0.9g of formaldehyde per 100g crude protein.

In general, the protected protein is as described in Australian Patent No. 659 557, the disclosure of which is incorporated herein by reference.

Preferably, the protected lipid and protein fed in accordance with any one of the seventh through to twelfth embodiments of the invention does not constitute the entire ration, but may be fed together with any other source of processed or unprocessed feedstuff.

According to a thirteenth embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method is in accordance with the first or fourth embodiments of the invention, and wherein said method further comprises simultaneously feeding to the female ruminant livestock protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

According to a fourteenth embodiment of the invention there is provided protected lipid in accordance with the second or fifth embodiments of the invention, further comprising protected carbohydrate, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

According to a fifteenth embodiment of the invention there is provided use of a protected lipid in accordance with the third or sixth embodiments of the invention, further comprising protected carbohydrate, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

It is preferred that about 40 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen. More preferably, about 50 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen. Still more preferably, about 60 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen. Even still more typically, about 65 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen.

According to a sixteenth embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method is in accordance with the first

or fourth embodiments of the invention, and wherein said method further comprises simultaneously feeding to the female ruminant livestock protected carbohydrate, wherein said protected carbohydrate is produced by the reaction with between about 0.1 grams and about 3 grams of formaldehyde per 100 grams carbohydrate.

According to a seventeenth embodiment of the invention there is provided protected lipid in accordance with the second or fifth embodiments of the invention, further comprising protected carbohydrate, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said protected carbohydrate is produced by the reaction with between about 0.1 grams and about 3 grams of formaldehyde per 100 grams carbohydrate.

According to an eighteenth embodiment of the invention there is provided use of a protected lipid in accordance with the third or sixth embodiments of the invention, further comprising protected carbohydrate, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said protected carbohydrate is produced by the reaction with between about 0.1 grams and about 3 grams of formaldehyde per 100 grams carbohydrate.

It is preferred that the protected carbohydrate is produced by the reaction with between about 0.1 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate. More preferably, the protected carbohydrate is produced by the reaction with between about 0.5 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate. Even more preferably, the protected carbohydrate is produced by the reaction with between about 1.0 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate. Still more preferably, the protected carbohydrate is produced by the reaction with between about 1.5 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate.

Preferably, the protected lipid and carbohydrate fed in accordance with any one of the thirteenth through to eighteenth embodiments of the invention does not constitute the entire ration, but may be fed together with any other source of processed or unprocessed feedstuff.

According to a nineteenth embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method is in accordance with the first or fourth embodiments of the invention, and wherein said method further comprises simultaneously feeding to the female ruminant livestock (i) protected protein,

such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

According to a twentieth embodiment of the invention there is provided protected lipid in accordance with the second or fifth embodiments of the invention, further comprising (i) protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids.

According to a twenty-first embodiment of the invention there is provided use of a protected lipid in accordance with the third or sixth embodiments of the invention, further comprising (i) protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids.

Typically, (i) about 65 to about 80% of protected protein is capable of passing undegraded through the rumen, and (ii) 40 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen. More typically, (i) about 70 to about 80% of protected protein is capable of passing undegraded through the rumen, and (ii) 50 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen. Still more typically, (i) about 72 to about 80% of protected protein is capable of passing undegraded through the rumen, and (ii) about 60 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen. Yet still more typically, (i) about 75 to about 80% of protected protein is capable of passing undegraded

through the rumen, and (ii) about 65 to about 80% of protected carbohydrates are capable of passing undegraded through the rumen.

According to a twenty-second embodiment of the invention there is provided a method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method is in accordance with the first or fourth embodiments of the invention, and wherein said method further comprises simultaneously feeding to the female ruminant livestock (i) protected protein, wherein said protected protein is produced by the reaction with between about 0.05g and about 1.0g of formaldehyde per 100g crude protein, and (ii) protected carbohydrate, and wherein said protected carbohydrate is produced by the reaction with between about 0.1 grams and about 3 grams of formaldehyde per 100 grams carbohydrate.

According to a twenty-third embodiment of the invention there is provided protected lipid in accordance with the second or fifth embodiments of the invention, further comprising (i) protected protein, wherein said protected protein is produced by the reaction with between about 0.05g and about 1.0g of formaldehyde per 100g crude protein, and (ii) protected carbohydrate, and wherein said protected carbohydrate is produced by the reaction with between about 0.1 grams and about 3 grams of formaldehyde per 100 grams carbohydrate, when used in altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids.

According to a twenty-fourth embodiment of the invention there is provided use of a protected lipid in accordance with the second or fifth embodiments of the invention, further comprising (i) protected protein, wherein said protected protein is produced by the reaction with between about 0.05g and about 1.0g of formaldehyde per 100g crude protein, and (ii) protected carbohydrate, wherein said protected carbohydrate is produced by the reaction with between about 0.1 grams and about 3 grams of formaldehyde per 100 grams carbohydrate, in the preparation of a feed for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids.

Typically, (i) the protected protein is produced by the reaction with between about 0.1g and about 1.0g of formaldehyde per 100g crude protein, and (ii) the protected carbohydrate is produced by the reaction with between about 0.1 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate. More typically, (i) the protected protein is produced by the reaction with between about 0.15g and about 1.0g of formaldehyde per 100g crude protein, and (ii) the protected carbohydrate is produced by the reaction with between about 0.5 grams and about 2.5 grams of formaldehyde per 100

grams carbohydrate. Even more typically, (i) the protected protein is produced by the reaction with between about 0.2g and about 1.0g of formaldehyde per 100g crude protein, and (ii) protected carbohydrate is produced by the reaction with between about 1.0 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate. More typically, (i) the protected protein is produced by the reaction with between about 0.2g and about 0.9g of formaldehyde per 100g crude protein, and (ii) the protected carbohydrate is produced by the reaction with between about 1.5 grams and about 2.5 grams of formaldehyde per 100 grams carbohydrate.

Preferably, the protected lipid, protein and carbohydrate fed in accordance with any one of the nineteenth through to twenty-fourth embodiments of the invention does not constitute the entire ration, but may be fed together with any other source of processed or unprocessed feedstuff.

According to a twenty-fifth embodiment of the invention there is provided a milk fat obtained from a female ruminant animal fed in accordance with the method of any one of the first, fourth, seventh, tenth, thirteenth, sixteenth, nineteenth or twenty-second embodiments of the invention, or obtained from a female ruminant animal fed a protected lipid, the lipid in accordance with the second, fifth, eighth, eleventh, fourteenth, seventeenth, twentieth or twenty-third embodiments of the invention, or obtained from a female ruminant animal fed a feed prepared in accordance with the use of any one of the third, sixth, ninth, twelfth, fifteenth, eighteenth, twenty-second or twenty-fourth embodiments of the invention.

Typically, the milk fat in accordance with the twenty-fifth embodiment of the invention is either a soft or hard fat. More typically, the milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

Typically, the milk fat obtained in accordance with the twenty-fifth embodiment of the invention is used in the production of milk based products. More typically, the milk based products may be selected from the group consisting of: milk, butter, cheese, yoghurt, chocolate and infant formula. Even more typically, the milk based product is butter having an altered spreadability.

Brief Description of the Drawings

Figure 1 illustrates a graphic representation of the role of feedstuffs, including protected lipids, in altering the proportions of fatty acids in milk. Figure 1 illustrates the differences in melting profiles between softer milk fats produced from cows receiving 2

kg and 3 kg of protected canola/soybean (7:3 w/w) supplement per day and normal milk fats derived from cows grazing pasture, together with a polyunsaturated margarine for comparison.

Figure 2 also illustrates a graphic representation of the role of protected lipids, in altering the proportions of fatty acids in milk, in this case, producing harder milk fats. Figure 2 reflects an increase in the proportion of C18:0 and a decrease in C18:1, thereby resulting in a substantial increase in both the melting point of milk fat and its hardness, and reference is made to Example 7 for the feeding regime which results in this fatty acid profile.

Definitions

In the context of the present invention, the following terms have the meanings set out below.

In this specification the term "simultaneously" is used to mean feeding of the ruminant livestock within a period of about 24 hours, that is, to realise the benefits of any one of the seventh through to twenty-fourth embodiments of the invention it is not essential that the intake of protected lipid and protected protein, and/or protected carbohydrate takes place at the same time, rather it is important that within a given 24 hour period the animals blood plasma is enriched with lipid, protein and/or carbohydrate constituents by absorption from the abomasum or lower digestive tract.

By "protected" we mean treated so as not to be fully exposed to the degradative action of the ruminant environment, but available for absorption from the abomasum or lower digestive tract. Lipids are protected by their encapsulation in a matrix of aldehyde treated protein. Importantly, the degree of protection of the formaldehyde-treated protein encapsulating the lipid is much greater than the degree of protection afforded the encapsulating protein alone. That is, the availability of the encapsulating protein protecting the lipid is sacrificed to a large extent in order to maintain the lipid beyond the rumen. Thus ensuring that almost all the protected lipid does indeed pass through the rumen undigested. For the purposes of this invention dietary lipids can be protected from ruminal metabolism by encapsulation in such a matrix of cross-linked proteins, and the preferred window of protection ranges from 60% to 90%. In terms of the protected protein constituent of feed of the invention, the degree of rumen protection lies in the range 60 to 80%, that is, 60 to 80% of the protein content of the supplement will pass undegraded through the rumen. Similarly, in terms of the protected carbohydrate constituent of feed of the invention, the degree of rumen protection lies in the range 30 to

80%, that is, 30 to 80% of the carbohydrate content of the supplement will pass undegraded through the rumen.

Suitable techniques should allow accurate control of the amount of cross-linking that occurs between the lipid, protein and carbohydrate feedstuffs, and the aldehyde. This may be achieved by varying the amount of aldehyde relative to the lipid, protein and carbohydrate content, so that the lipid, protein and carbohydrate is optimally "protected" from rumen degradation, but may be completely digested and absorbed from the small intestine.

"Protected lipid" is defined as lipid soluble material that normally contains long chain fatty acids and is treated either chemically or physically to reduce its degradation in the rumen, but allows the fatty acids to be available for absorption from the intestine. The degree of protection ranges from about 60 to about 90%, that is, about 60 to about 90% of the fat supplement will pass undegraded through the rumen. In the context of the present invention when protected lipid is fed, a degree of protection of about 75 to about 90% is preferred.

"Protected protein" is defined as proteinaceous material that is treated chemically or physically to reduce the rate of degradation of the constituent amino acids in the rumen. The degree of protection will vary from about 60 to about 80%, that is, about 60 to about 80% of the protein will pass undegraded through the rumen. In the context of the present invention when protected protein is fed, a degree of protection of about 70-75 to about 80%, is preferred.

"Protected carbohydrate" is defined as carbohydrates or carbohydrate containing material that is treated chemically or physically to reduce the rate of degradation in the rumen but allows the carbohydrate to be readily digested in the small intestine. The degree of protection will vary from about 30 to about 80%, that is, about 30 to about 80% of the carbohydrate will pass undegraded through the rumen. In the context of the present invention when protected carbohydrate is fed, a degree of protection of about 65 to about 80% is preferred.

By "grain" we mean plant derived concentrates, and these include barley, wheat, oats, sorghum etc.

By "carbohydrate" we mean complex carbohydrates such as polyhydroxy aldehydes, ketones, alcohols or acids, their derivatives, and any compound that may be hydrolysed to these.

"Protein" is defined as proteinaceous material containing individual amino acids linked together.

"Fat" is defined as lipid soluble material and normally contains long chain fatty acids of carbon chain length >C10.

By "roughage" we mean plant derived cellulose materials containing varying proportions of fibre which are digested at different rates in the rumen.

By "minerals and vitamins" we mean supplement of anions, cations, trace elements and fat-soluble vitamins A, C, D and E that are normally included in feed rations.

Best Modes of Carrying Out the Invention

In the performance of this invention in general, protected lipid is included in the ration in an amount up to about 45% of dry matter intake. More preferably, protected lipid is included in the ration in an amount between about 10% to about 30% of dry matter intake. Even more preferably, in an amount between about 8% to about 16% of dry matter intake. Still more preferably, in an amount between about 8% to about 12% of dry matter intake.

However, it is likely to be most practical to feed animals protected lipid as a supplement which also combines both a protected protein and a protected carbohydrate. In those instances where protected lipids are used in combination with protected carbohydrate and/or protected protein, a ratio of 1:1:1 w/w/w is often used to manufacture the protected feed supplement, and the supplement is typically included in the ration at about 10-45% during the lactation phase. Preferably the protected feed supplement is included in the ration at about 15-45% of dry matter intake during the lactation phase, more preferably, at about 15-30% of dry matter intake during the lactation phase, and even more preferably, at about 20-30% of dry matter intake during the lactation phase.

Preferably, the protected feed supplements are fed at a rate of between about 3 and about 5 kilograms per ruminant animal per day. More preferably, the protected feed supplements are fed at a rate of between about 4 and about 5 kilograms per ruminant animal per day.

Examples of the mechanisms by which protected lipid, protected protein and protected carbohydrate may be produced are described in Examples 8, 9 and 10 respectively.

An economically viable source of lipid, carbohydrate and protein is likely to be cereal grain. Sources of such cereal grain are likely to include: barley, maize, oats, wheat, rice, millet, triticale, rye, and sorghum. Other sources of lipid, carbohydrate and protein include oil seed, oil and lipids, derived from plants, animals and the by-products of food

processing for human consumption. As described by Kirk-Othmer (1980), sources of such oilseeds, oil and lipids include the following: corn, soybean, cotton, lupin, peanut, sunflower, canola, sesame seed oil, olive oil, copra and coconut oil, palm kernels and palm oil, casein, butterfat, lard, fish oils, linseed and oil, tung oil, tallow and yellow grease. A still further source of lipid includes lipid products or conjugated linoleic acid products, derived from oil sources via chemical, microbiological or biotechnology processes, including, alkali isomerisation techniques, or mixtures thereof; or other naturally occurring sources of oils/oilseeds that contain inhibitors of the desaturase enzyme systems which operate in ruminant tissues, wherein examples of these inhibitors include cyclopropinoids such as sterculate.

The wide diversity of lipid sources offers the flexibility to select components of the lipid according to the relative prices and availability of raw materials, and the same holds for carbohydrate or protein sources. The selection of the source of the lipid, carbohydrate and/or protein to be protected, is normally dependent on their seasonal availability and price. There is no particular inherent advantage provided by feeding any one lipid, nor for that matter, any one carbohydrate or protein source which precludes its use over another, provided of course that the source of lipid is such that it produces the desired proportions of fatty acids in the milk products.

Clearly the benefits possible from practising this invention can be expected to be related to the continuity and period of feeding the protected lipid and to amounts fed, but other factors such as animal specifications, eg. genotype, age, and physiological condition and the environmental situation (temperature, humidity), should also be taken into account when deciding on the feeding regime to be adopted.

In one aspect of the invention, softer milk fats may be obtained through the feeding of protected canola seed, sunflower seed, or any other oleyl or linoleyl oil containing oil seed, that is fats containing C18 monounsaturated or polyunsaturated fats. For example, lipids high in C18:1, C18:2 and C18:3 fatty acids.

Furthermore, the softer milk fats may be obtained through the feeding of protected fish oils. For example, lipids high in C20 or C22 polyunsaturated fatty acids, such as C22:5 and/or C22:6 fatty acids.

In a more preferred aspect, the present invention provides a method for producing softer milk fat containing less saturated and more unsaturated fatty acids, which comprises the feeding of canola/soybean oilseed supplement in ratios of (3:1 to 1:3 w/w) protected from ruminal degradation.

Preferably, the softer milk fat obtained via the feeding regime of the present invention may contain the following proportions of fatty acids: C18:1 cis (25-45%w/w), C18:2 (4-15%w/w) and C18:3 (1-8%w/w). Even more preferably, the softer milk fat obtained via the feeding regime of the present invention may contain the following proportions of fatty acids: C18:1 cis (30-40%w/w); C18:2 (6-10%w/w), including proportions (0.5 to 5%) of conjugated isomers, C18:3 (2-4%w/w); C20:5 and/or C22:6 (1-2% w/w).

In another aspect of the invention, there is provided a method for producing harder milk fat containing more saturated and less unsaturated fatty acids, which comprises for example the feeding of cotton oilseed supplements protected from ruminal degradation.

In another aspect of the invention, the harder milk fats may be obtained through the feeding of protected oils enriched in saturates, for example hydrogenated fats.

Preferably, the harder milk fats may be obtained through the feeding of protected cotton seed, due to the presence of cyclopropene fatty acids and additional dietary C18:2 which acts to inhibit Δ9 desaturase enzyme, an enzyme which converts additional C18:0 into C18:1 within the mammary gland.

Preferably, the harder milk fat obtained via the feeding regime of the present invention may contain the following proportions of fatty acids: 25-35%w/w C16:0, 20-30%w/w C18:0 and 20-25%w/w C18:1. More preferably, 28-35%w/w C16:0, 25-30%w/w C18:0 and 22-25%w/w C18:1, and still more preferably, 0-35%w/w C16:0 and 25-30% C18:0%w/w.

The milk fat produced by the feeding regime of the present invention may be used in all milk based products, including for example: milk, butter, cheese, yoghurt, chocolate and infant formulas.

Milk based products with the fatty acid characteristics obtained through the feeding regime of the present invention, such as for example: butter, cheese, yoghurt, chocolate and infant formulas, are produced according to the relevant manufacturing processes well accepted in the art.

Preferably, butter derived from the softer milk fat produced by the feeding regime of the present invention provides improved spreadability.

Preferably, milk based products with the fatty acid characteristics obtained through the feeding regime of the present invention contain a desirable ratio of n-6/n-3 fatty acids for human nutrition. More preferably, a desirable ratio of n-3/n-3 fatty acids is considered to be 5:1 or less. For example, in Table 2, a ratio of 3.1:1 was achieved by

feeding protected canola soybean supplements to dairy cows at the rate of approximately 2.5 kg per head per day, equivalent to 750g fat (see Table 1).

In accordance with the invention, the feeding of protected lipid, together with protected protein and protected carbohydrate, in addition to designing milk fat profiles, also results in improvements in relation to growth rate and/or carcass quality.

Test Methods

1. *In-Vitro* Biological Evaluation of Feed Supplements

(a) Ruminal hydrogenation of unsaturated lipids.

Samples of unsaturated lipid supplements (containing ca. 40-50mg of oil) are incubated in test tubes with 10mL of strained rumen fluid. The tubes are flushed with nitrogen, capped with rubber serum caps and incubated in a shaking water bath at 38°C for periods up to 20h. The incubated and corresponding unincubated reaction mixtures are saponified and the fatty acids extracted and methylated. The methyl esters are analysed by gas liquid chromatography (GLC), and the extent of protection against ruminal hydrogenation calculated using the formula:

$$\text{Protection (\%)} = \frac{\text{\% 18:2 after incubation}}{\text{\% 18:2 before incubation}} \times 100$$

The endogenous level of polyunsaturated fatty acids in the rumen fluid was always less than 2% by weight of the total fatty acid, and thus had little effect on the above calculations. The hydrogenating capacity of each batch of rumen fluid is verified by incubating the rumen fluid with samples of polyunsaturated oil-casein supplements prepared without formalin.

(b) Ruminal lipolysis of triacylglycerol

Samples of the lipid supplements (containing ca. 40-50mg of lipid) are incubated with 10mL of strained rumen fluid as described above. When the extent of triacylglycerol (TG) hydrolysis is measured by GLC, heptadecanoic acid (17:0)(20mg) is added to each reaction tube as an internal standard.

The incubated and corresponding unincubated reaction mixtures are extracted with 10mL of chloroform-methanol (C/M 2:1 v/v) containing 0.5mL of 5M HCl. The mixtures of rumen fluid and acidic C/M are vigorously shaken and allowed to stand for 2-4h until two phases were clearly distinguished.

The upper aqueous phase is removed and discarded and the lower organic phase filtered to remove suspended matter. The filtrate is evaporated to dryness using rotary

film evaporator, and the extent of TG hydrolysis estimated using either thin layer chromatography (TLC), or if 17:0 was added, GLC methods described below.

(i) TLC analysis of the extracted lipids is carried out using silica gel G and a solvent system of petroleum ether: diethyl ether:acetic acid (84:15:1, v/v/v). The separated lipids are visualised by spraying with an ethanolic solution of 2,7-dichlorofluorescein (0.2% w/v) and viewing under UV light. The extent of TG hydrolysis can only be estimated qualitatively by comparing the relative intensities and sizes of the TG and free fatty acid (FFA) spots in both the incubated and the unincubated reaction mixtures.

(ii) GLC analysis is used in conjunction with the 17:0 internal standard to assess the degree of TG lipolysis. This method relies on the determination of the proportion of 17:0 in the FFA fraction of the incubated and the unincubated lipid extracts. The dilution of 17:0 in the FFA fraction which occurs during incubation is used as an index of ruminal lipolysis. The FFA in the lipid extracts are methylated with diazomethane and the methyl esters separated by GLC. In addition, samples of the total lipid extracts are saponified, acidified, and extracted with petroleum ether, and the total fatty acids obtained are also methylated with diazomethane and analysed by GLC. The GLC 17:0 measurements were used to estimate the following values:

TFA t_0 = Total fatty acids at 0h

TFA t_{20} = Total fatty acids at 20h

FFA t_0 = Free fatty acids at 0h

FFA t_{20} = Free fatty acids at 20h

EFFA t_0 = Endogenous ruminal free fatty acids at 0h (from unincubated rumen fluid controls)

EFFA t_{20} = Endogenous ruminal free fatty acids at 20h (from incubated rumen fluid controls).

From these values it was possible to calculate the following two other values:

RFA t_0 (released fatty acids at 0h) = FFA t_0 - EFFA t_0

and

RFA t_{20} (released fatty acids at 20h) = FFA t_{20} - EFFA t_{20}

The resistance to ruminal lipolysis is then calculated using the formula:

$$\text{Resistance (\%)} = \frac{\text{TFA } t_{20} - \text{RFA } t_{20}}{\text{TFA } t_0 - \text{RFA } t_0} \times 100$$

(c) Ruminal carbohydrate protection

The protection of carbohydrate is determined by the measurement of the residual starch remaining after 24h *in sacco*. 5g of treated or untreated carbohydrate are sealed into 3x5cm nylon bags (52im pore size) which are inserted with appropriate weights in the rumen of a sheep for 24h. These bags are removed, washed in deionised water and freeze dried and the weight of residue remaining determined. The residues and incubated samples are ground through a mill (containing a 0.5mm screen) and the starch determined on a 100mg sub-samples enzymatically using a "Megazyme" total starch assay kit (distributed by Deltagen Australia, 31 Wadhurst Drive, Boronia, Victoria Australia. 3155). All starch values measured are corrected to known standards provided in the kit. The protection of the protected carbohydrate is then calculated as the ratio of the total starch in the untreated and treated sample.

(d) Ruminal protein solubility

The release of ammonia during *in vitro* incubation with rumen fluid is used as a measure of the solubility of the proteins. To 10mL of strained rumen fluid, sufficient lipid supplement is added to supply 75mg of protein, and the mixture was incubated anaerobically at 37°C for 20h. The reaction flasks including rumen fluid blanks are treated with 5mL of 0.2 M H_2SO_4. The mixtures are centrifuged to remove suspended matter, and ammonia is estimated in the supernatant after steam distillations. Net ammonia production is calculated from the difference between the incubated and blank values corrected for ammonia initially present.

2. *In-vivo* Biological Evaluation of Supplements

(a) Ruminal carbohydrate protection

The protection of carbohydrate is determined by the measurement of the residual starch remaining after 24h *in sacco*. 5g of treated or untreated carbohydrate are sealed into 3x5cm nylon bags (52µm pore size) which are inserted with appropriate weights in the rumen of a sheep for 24h. These bags are removed, washed in deionised water and freeze dried and the weight of residue remaining determined. The residues and incubated samples are ground through a mill (containing a 0.5mm screen) and the starch determined on a 100mg sub-samples enzymatically using a "Megazyme" total starch assay kit (distributed by Deltagen Australia, 31 Wadhurst Drive, Boronia, Victoria Australia. 3155). All starch values measured are corrected to known standards provided in the kit. The protection of the protected carbohydrate is then calculated as the ratio of the total starch in the untreated and treated sample.

(b) Ruminal hydrogenation of unsaturated lipids.

This technique is dependent on evidence that the total long chain fatty acids passing from the abomasum is approximately equal to the intake in the diet. Hence the change in concentration of 18:2 and 18:3, gives an approximation of the degree of hydrogenation. The animals are fed basal diets of chopped alfalfa hay and oats (1:1, w/w) 800g/day. The abomasal digesta is sampled via an abomasal fistula at various time periods and ca. 20mL of digesta saponified and fatty acids extracted as described for the rumen fluid incubations. The extracted fatty acids are methylated and analysed by GLC. The proportion of polyunsaturated fatty acid (eg., 18:2) in the abomasal lipids is compared with a theoretical level estimated by assuming (a.) that all of the 18:2 in the lipid supplement was protected against ruminal hydrogenation; (b.) that all of the 18:2 in the basal diet was hydrogenated; and (c.) that there was no significant synthesis or degradation of the carbon skeleton of fatty acids by micro-organisms. The *in vivo* protection of these supplements is calculated using the formula:

$$\% \text{ protection} = \frac{\text{Actual \% 18:2 in abomasum}}{\text{Theoretical \% 18:2 in abomasum}} \times 100$$

As an example, a sheep receiving 400g of alfalfa hay, 400g of crushed oats and 300g of a formaldehyde treated safflower oil/casein (2:1 w/w) supplement would receive 3% of the basal diet of alfalfa and oats as fatty acids, ie., 24g, and 178g of fatty acids from the lipid supplement (corrected for glycerol moiety).

The 18:2 content of the supplementary fatty acids is 75% or 134 g. Using the above assumptions, the content of 18:2 in the abomasal fatty acids should be 134/(178 + 24) = 66%. If the actual 18:2 content of abomasal fatty acids is 53%, then the percentage protection $= \frac{53}{66} \times 100 = 80\%$.

3. Other Chemical Analyses

Moisture content of feed ingredients is determined by heating at 100°C for at least 12h. Protein content is determined by the Kjeldahl method. Formaldehyde content of supplements is determined by the method of Van Dooren J. Sci. Food Agric. (1975). 26: 1263.

The invention will now be described in greater detail by reference to specific to examples, which should not be construed as limiting on the scope thereof.

Examples

Example 1: Feed Supplements for the Production of Softer Fats

Feeding to lactating cows a canola/soybean blend (7:3w/w) supplement (75% protected from ruminal hydrogenation) at the rate of approximately 10% of dry matter intake, provided about 750 g fat. The fatty acid composition of the supplement and the daily intake of fatty acid per cow per day are provided below in table 1.

Table 1: Composition of Canola/Soybean Supplement (7:3 w/w) and daily intake of fatty acids

Fatty Acid	% by Wt	g/d
18:1	51.2	345.6
18:2	28.7	193.7
18:3	10.7	72.2

Example 2: Feed Composition for the Production of Softer Fats

From the supplements described in Example 1, the following fatty acid profile was obtained from cows grazed at pasture and supplemented with the protected lipid once daily, and wherein milk was sampled after the morning milking. Control cows were grazed at pasture and were supplemented during milking with about 4kg/d of a dairy concentrate pellet containing no protected fat. The fatty acid composition of the control and fat-modified dairy products is outlined below in Table 2.

Table 2: Mean fatty acid profiles of control and fat-modified dairy products

Fatty Acid	Control % by wt of total fatty acids	Fat-Modified
Butyric (4:0)	5.7	5.5
Caproic (6:0)	2.7	2.5
Caprylic (8:0)	2.9	1.3
Capric (10:0)	2.8	2.3
Lauric (12:0)	3.3	2.3
Myristic (14:0)	10.0	6.7
Palmitic (16:0)	25.9	15.5

Stearic (18:0)	11.7	14.3
Oleic (18:1)	22.8	35.3
Linoleic (18:2)	1.5	6.9
Linolenic (18:3)	0.7	2.2

Example 3: Feed supplement for the production of milk fat enriched with C20 and C22 n-3 fatty acids

Feeding lactating cows a rumen protected tuna oil-soybean lipid:protein (sunflower meal) (23:67:10; w/w/w) supplement (75% rumen protection *in vitro*) at the rate of approximately 2.2Kg/h/day, the following fatty acid profile was obtained. Control cows were grazed at pasture and were supplemented during milking with about 4kg/d of a dairy concentrate pellet containing no protected fat. The fatty acid composition of the control and fat-modified dairy products is outlined below in Table 3:

Table 3. Fatty acid profile of control and C20, C22 (n-3) enriched milk fat

Fatty acid	Control milk fat	n-3 enriched milk fat
< C14:0	13.7	7.6
C14:0	11.0	8.7
C16:0	31.1	23.6
C16:1	1.5	1.1
C18:0	10.8	11.9
C18:1	23.6	27.6
C18:2	2.4	6.2
C18:3	0.2	1.3
C20:5	Nd	0.5
C22:6	Nd	1.0

Nd=not detectable

Note the significant increase in the proportion of the C20:5 and C22:6 fatty acids in milk from cows consuming protected tuna oil supplement.

Example 4: Feed supplements for the production of milk fat enriched with C18 n-3 fatty acids

Feeding lactating cows a mixture containing 90 parts of rumen protected linseed oil-soybean lipid (3:7w/w; 80% rumen protection *in vitro*) and 10 parts of rumen protected sunflower meal protein (60% rumen protection *in vitro*) at the rate of approximately 1.5Kg/h/day, the following fatty acid profile was obtained. Control cows were grazed at pasture and were supplemented during milking with about 4kg/d of a dairy concentrate pellet containing no protected fat. The fatty acid composition of the control and fat-modified dairy products is outlined below in Table 4:-

Table 4. Fatty acid profile of control and C18 (n-3) enriched milk fat

Fatty acid	Control milk fat	n-3 enriched milk fat
C8:0	2.0	2.0
C10:0	2.5	2.5
C12:0	2.7	2.6
C14:0	10.6	8.3
C16:0	30	18.6
C16:1	0.4	0.4
C18:0	8.2	11.5
C18:1 cis	24.5	24.0
C18:1 trans	2.2	2.9
C18:2	2.6	8.2
C18:3	0.7	8.6

Note the significant increase in the proportion of the C18 n-3 fatty acids content in milk fat from cows consuming protected linseed oil supplement.

Example 5: Feed supplement for the production of milk fat enriched in C18:1 cis mono-unsaturated fat

Feeding lactating cows a rumen protected sunola oil:casein supplement (1:1: w/w) (80% rumen protection *in vitro*) containing 10% protected protein (sunflower meal) supplement at the rate of 3Kg/h/d, the following fatty acid profile was obtained. As per the examples outlined above, control cows were grazed at pasture and were supplemented during milking with about 4kg/d of a dairy concentrate pellet containing no protected fat.

The fatty acid composition of the control and fat-modified dairy products is outlined below in Table 5:-

Table 5. Fatty acid profile of control and C18:1 *cis* enriched milk fat

Fatty acid	Control milk fat	n-3 enriched milk fat
C8:0	2.5	2.0
C10:0	3.0	1.7
C12:0	3.0	2.0
C14:0	10.6	7.5
C16:0	31.7	18.2
C16:1	1.6	0.6
C18:0	13.4	13.2
C18:1 cis	21.6	43.2
C18:1 trans	2.1	1.9
C18:2	2.0	3.6
C18:3	0.5	0.7

Note the significant increase in the C18 cis monounsaturated fatty acid in milk fat from cows fed the protected sunola oil supplement.

The following table demonstrates that the feeding of rumen protected lipid supplements significantly increases the proportion of fats that is soft at different temperatures.

Table 6. The melting characteristics of milk fat from cows at Pasture or supplemented with rumen protected lipids

Melting Characteristics	Pasture	Linseed-Soybean lipid	Tuna oil-Soybean lipid
Liquid at 5° C (%)	35.3	65.1	55.4
Liquid at 20° C (%)	68.3	90.4	86.5

Example 6: Feed supplements for the production of milk fat enriched with C18 conjugated linoleic acid (CLA's).

Feeding to lactating goats a rumen protected CLA/casein supplement (1:1; w/w) (70% rumen protection *in vitro*) at the rate of 80g /h/d produced the following fatty acid profile in milk, the following fatty acid profile was obtained. Control goats were fed 2.4 kg/d of lucerne chaff/oat grain (60:40 w/w). The fatty acid composition of the control and fat-modified dairy products is outlined below in Table 7:-

Table 7. Fatty acid profile of control and CLA enriched milk fat from goats

Fatty acid	Control milk fat	n-3 enriched milk fat
< C14:0	11.1	6.4
C14:0	8.3	6.7
C16:0	23.6	22.1
C18:0	14.7	23.5
C18:1	26.1	22.6
C18:2	2.2	2.7
C18:3	0.7	0.7
CLA 9c, 11t	0.6	2.2
CLA 10t, 12c	nd	1.9

Nd=Not detected

Note the significant increase in the two major CLA isomers (9 *cis*, 11 *trans*; 10 *trans*, 12 *cis*) in milk fat from goats fed the protected CLA supplement.

Example 7: Feed Composition for the Production of Harder Fats

In this example, the proportion of C18:0 increased and there was a decrease in C18:1, thereby resulting in a substantial increase in both the melting point of milk fat and its hardness. This change is outlined in Figure 2, and again illustrates the role of protected lipids in altering the proportions of fatty acids in milk.

The feeding regime used to induce the changes in Figure 2 comprised a basal ration of lucerne hay and oat grain (1:1, w/w) supplemented with varying levels of protected cotton seed ranging from 0-80% which replaced a canola soybean (80:20, w/w) supplement to provide 110 grams of protected fat per day.

Example 8: Protected Lipid Preparation

Cottonseed was coarsely comminuted in a hammer mill and mixed with ethoxyquin (150ppm on an oil basis). This material was then mixed with water to produce a slurry and, after emulsification of the oil and protein in a colloid-stone mill, the caustic soda was added to solubilise the oilseed protein. The protein constituents of the homogenised oil seed were cross-linked with 37% (w/v) formaldehyde at the rate of approximately 1.5-3g formaldehyde per 100g crude portion to form a gel which was then dried in a pneumatic drier with an average hot air temperature of 300°C to complete the reaction and produced a protected lipid that was 60-90% resistant to metabolism in the rumen *in vitro*.

(a) Protected Canola Lipid

Canola lipid was emulsified with protein, and the protein constituents of the homogenised oil seed were cross-linked with formaldehyde at a rate of approximately 2.5g formaldehyde per 100g crude portion producing a supplement that was 75% resistant to metabolism in the rumen *in vitro*.

(b) Protected Cotton Lipid

Cotton lipid was emulsified with protein, and the protein constituents of the homogenised oil seed were cross-linked with formaldehyde at a rate of approximately 3.0g formaldehyde per 100g crude portion producing a supplement that was 80% resistant to metabolism in the rumen *in vitro*.

(c) Protected Cotton - Tallow Lipid

Cotton-tallow lipid was emulsified with protein, and the protein constituents of the homogenised oil seed were cross-linked with formaldehyde at a rate of approximately 2.5g formaldehyde per 100g crude portion producing a supplement that was 80% resistant to metabolism in the rumen *in vitro*.

(d) Protected Fish Oil - Soybean Lipid

Soybean-fish oil was emulsified with protein, and the protein constituents of the homogenised oil seed were cross-linked with formaldehyde at a rate of approximately 2.5g formaldehyde per 100g crude portion producing a supplement that was 75% resistant to metabolism in the rumen *in vitro*.

(e) Protected Linseed Oil - Soybean Lipid

Soybean-Linseed oil was emulsified with protein, and the protein constituents of the homogenised oil seed were cross-linked with formaldehyde at a rate of approximately 2.5g formaldehyde per 100g crude portion producing a supplement that was 80% resistant to metabolism in the rumen *in vitro*.

(f) Protected Sunola - Soybean Lipid

Soybean-Sunola oil was emulsified with protein, and the protein constituents of the homogenised oil seed were cross-linked with formaldehyde at a rate of approximately 2.5g formaldehyde per 100g crude portion producing a supplement that was 75% resistant to metabolism in the rumen *in vitro*.

(g) Protected Conjugated linoleic acids (CLA)

An oil containing 60% conjugated linoleic acid was emulsified with casein, and the protein constituents of the homogenised oil were cross-linked with formaldehyde at a rate of approximately 2.5g formaldehyde per 100g crude portion, producing a supplement that was 70% resistant to metabolism in the rumen *in vitro*.

Example 9: Protection of Protein Supplements

Protected protein was prepared by spraying 37% (W/V) formaldehyde at the rate of between 0.05 and 0.8g formaldehyde per 100g crude protein into a rapid mixing device containing milled oil seed meal (38% crude protein). This material was then transferred to sealed storage for 10 days to give a supplement 50-70% resistant to proteolysis in the rumen.

(a) Protected Sunflower Protein

Protected sunflower protein was prepared by reacting approximately 0.7g formaldehyde per 100g with milled sunflower seed meal (38% crude protein, 2% crude lipid), producing a supplement 65% resistant to proteolysis in the rumen.

(b) Protected Canola Protein

Protected canola protein was prepared by reacting approximately 0.5g formaldehyde per 100g with milled canola seed meal (38% crude protein, 2% crude lipid), producing a supplement 70% resistant to proteolysis in the rumen.

(c) Protected Lupin Protein

Protected lupin protein was prepared by reacting approximately 0.6g formaldehyde per 100g with milled lupin seed meal (38% crude protein, 5% crude lipid), producing a supplement 65% resistant to proteolysis in the rumen.

(d) Protected Cottonseed Protein

Protected cottonseed protein was prepared by reacting approximately 0.3g formaldehyde per 100g with milled cottonseed seed meal (38% crude protein, 2% crude lipid), producing a supplement 75% resistant to proteolysis in the rumen.

Example 10: Protection of Carbohydrate Supplements

Grain was coarsely comminuted in a hammer mill to a particle size of approximately 2.5mm or smaller. Protected carbohydrate was then prepared by spraying 37% (W/V) formaldehyde at the rate of between 0.1 and 3.0 grams formaldehyde per 100g crude carbohydrate into a rapid mixing device containing milled concentrate. This material was then transferred to sealed storage for 10 days to give a protected carbohydrate supplement 30-80% resistant to degradation in the rumen.

(a) Protected Wheat Carbohydrate

Protected wheat carbohydrate was prepared by reacting approximately 1.2g formaldehyde per 100g with milled wheat, producing a supplement 65% resistant to degradation in the rumen.

(b) Protected Barley Carbohydrate

Protected barley carbohydrate was prepared by reacting approximately 1.4g formaldehyde per 100g with milled barley, producing a supplement 70% resistant to degradation in the rumen.

Industrial Applicability

The present invention makes use of nutritional materials protected against rumen degradation, but offers the possibility of altering the fatty acid profile of milk produced from female ruminant livestock. In particular, it describes feed supplements which produce milk with a desired fatty acid composition and are useful in producing products with a range of melting profiles. Practise of this invention can be expected to offer economic benefits irrespective of the type of animal in question.

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Claims

1. A method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions and/or types of fatty acids, wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally.

2. The method according to claim 1, wherein about 75 to about 90% of protected lipid is capable of passing undegraded through the rumen.

3. A method for altering the fatty acid profile of milk from female ruminant livestock to have desired proportions of fatty acids, wherein said method comprises feeding to the ruminant livestock protected lipid having said desired proportions of fatty acids, wherein said protected lipid is produced by the emulsification of lipid with protein in the presence of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion.

4. The method according to claim 3, wherein the protected lipid is produced by the reaction with between about 2.0 grams and about 2.6 grams of formaldehyde per 100 grams crude portion.

5. The method according to any one of claims 1 to 4, wherein the desired proportions and/or types of fatty acids are: C18:1 cis (25-45%w/w); C18:2 (4-15%w/w), including conjugated isomers (0.05 to 5%w/w), C18:3 (1-8%w/w); C20:5 and C22:6 omega fatty acid (1-3%w/w).

6. The method according to any one of claims 1 to 4, wherein the desired proportions and/or types of fatty acids are: C16:0 cis (25-35%w/w), C18:0 (20-30%w/w) and C18:1 (20-25%w/w).

7. The method according to any one of claims 1 to 6, wherein the source of lipid is selected from the group consisting of: soybean, cotton, lupin, peanut, sunflower, canola, sesame seed, copra and coconut, palm kernels, linseed, casein, butterfat, lard, fish oils, tung oil, tallow, and oil lipid products derived from oil sources by chemical/biological processes, or a combination thereof.

8. The method according to claim 7, wherein the source of oil lipid product is conjugated linoleic acid.

9. The method according to claim 7, wherein the source of lipid is derived from oil sources by chemical/biological processes, or a combination thereof.

10. The method according to any one of claims 1 to 9, wherein the source of lipid is yellow grease.

11. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein available for digestion post-ruminally.

12. The method according to any one of claims 1 to 11, further comprising simultaneously feeding to the ruminant livestock protected carbohydrate such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

13. The method according to any one of claims 1 to 11, further comprising simultaneously feeding to the ruminant livestock: (i) protected protein, such that such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally

14. A method according to any one of claims 11-13, wherein the source of protein and/or carbohydrate is plant and includes any one of, or a combination of barley, corn, oats, wheat, rice, millet, triticale, rye, and sorghum, soybean, cotton, lupin, peanut, sunflower, canola, sesame seed, copra and coconut, palm kernels and linseed.

15. The method according to any one of claims 1 to 14, further comprising, feeding to the ruminant livestock any other source of processed or unprocessed feedstuff.

16. The method according to any one of claims 13 to 15, wherein the protected carbohydrate, protected protein and/or protected lipid is included in the ration at about 10-45% during the lactation phase.

17. Milk fat obtained from a ruminant fed according to the method of any one of claims 1 to 16.

18. The milk fat of claim 17, wherein said milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

19. The milk fat of claim 17, wherein said milk fat is comprised of hard fats.

20. The milk fat of any one of claims 17 to 19, wherein said milk fat is used in the production of milk based products.

21. The milk fat of any one of claims 17 to 20, wherein said milk based products include: milk, butter, cheese, yoghurt, chocolate or infant formula.

AMENDED CLAIMS

[received by the International Bureau on 15 December 2000 (15.12.00); original claims 1 – 10 amended; other claims unchanged (3 pages)]

1. A method for altering the fatty acid profile of milk from female ruminant livestock to comprise at least one of the following types and proportions of fatty acids in said milk: C18:1 *cis* (25-45%w/w); C18:2 (4-15%w/w); C18:3 (1-8%w/w); C20:5 and C22:6 omega fatty acid (1-3%w/w), or a combination thereof, wherein said method comprises feeding to the female ruminant livestock, protected lipid such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

2. The method of claim 1, wherein said fatty acid profile comprises at least one of: C18:1 *cis* (30-45%w/w); C18:2 (6-10%w/w); C18:3 (2-4%w/w); C20:5 and C22:6 omega fatty acid (1-2%w/w), or a combination thereof.

3. The method of claim 1 or 2, wherein said C18:2 further includes conjugated isomers (0.5 to 5%w/w).

4. A method for altering the fatty acid profile of milk from female ruminant livestock to have at least one of the following types and/or proportions of fatty acids in said milk: C16:0 *cis* (25-35%w/w), C18:0 (20-30%w/w) and C18:1 (20-25%w/w), wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions and/or types of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

5. The method of claim 4, wherein said fatty acid profile comprises at least one of: C16:0 *cis* (28-35%w/w), C18:0 (25-30%w/w) and C18:1 (22-25%w/w), or a combination thereof.

6. The method according to any one of claims 1-5, wherein about 75 to about 90% of protected lipid is capable of passing undegraded through the rumen.

7. The method according to any one of claims 1-6, wherein the protected lipid is produced by the reaction with between about 2.0 grams and about 2.6 grams of formaldehyde per 100 grams crude portion.

8. The method according to any one of claims 1 to 7, wherein the source of lipid is selected from the group consisting of: soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels, linseed, casein, butterfat, yellow grease, lard, fish oils, tung oil, tallow, and oil lipid products derived from oil sources by chemical/biological processes, or a combination thereof.

9. The method according to claim 8, wherein the source of oil lipid product is conjugated linoleic acid or chemical forms thereof.

10. The method according to claim 9, wherein the source of lipid is derived by chemical/biological processes, or a combination thereof.

11. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein available for digestion post-ruminally.

12. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected carbohydrate such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

13. The method according to any one of claims 1 to 10 further comprising simultaneously feeding to the ruminant livestock: (i) protected protein, such that such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

14. A method according to any one of claims 11-13, wherein the source of protein and/or carbohydrate is plant and includes any one of, or a combination of barley, corn, oats, wheat, rice, millet, triticale, rye, and sorghum, soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels and linseed.

15. The method according to any one of claims 1 to 14, further comprising, feeding to the ruminant livestock any other source of processed or unprocessed feedstuff.

16. The method according to any one of claims 13 to 15, wherein the protected carbohydrate, protected protein and/or protected lipid is included in the ration at about 10-45% during the lactation phase.

17. Milk fat obtained from a ruminant fed according to the method of any one of claims 1 to 16.

18. The milk fat of claim 17, wherein said milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

19. The milk fat of claim 18, wherein said milk fat is comprised of hard fats.

20. The milk fat of any one of claims 17 to 19, wherein said milk fat is used in the production of milk based products.

21. The milk fat of any one of claims 17 to 20, wherein said milk based products include: milk, butter, cheese, yoghurt, chocolate or infant formula.

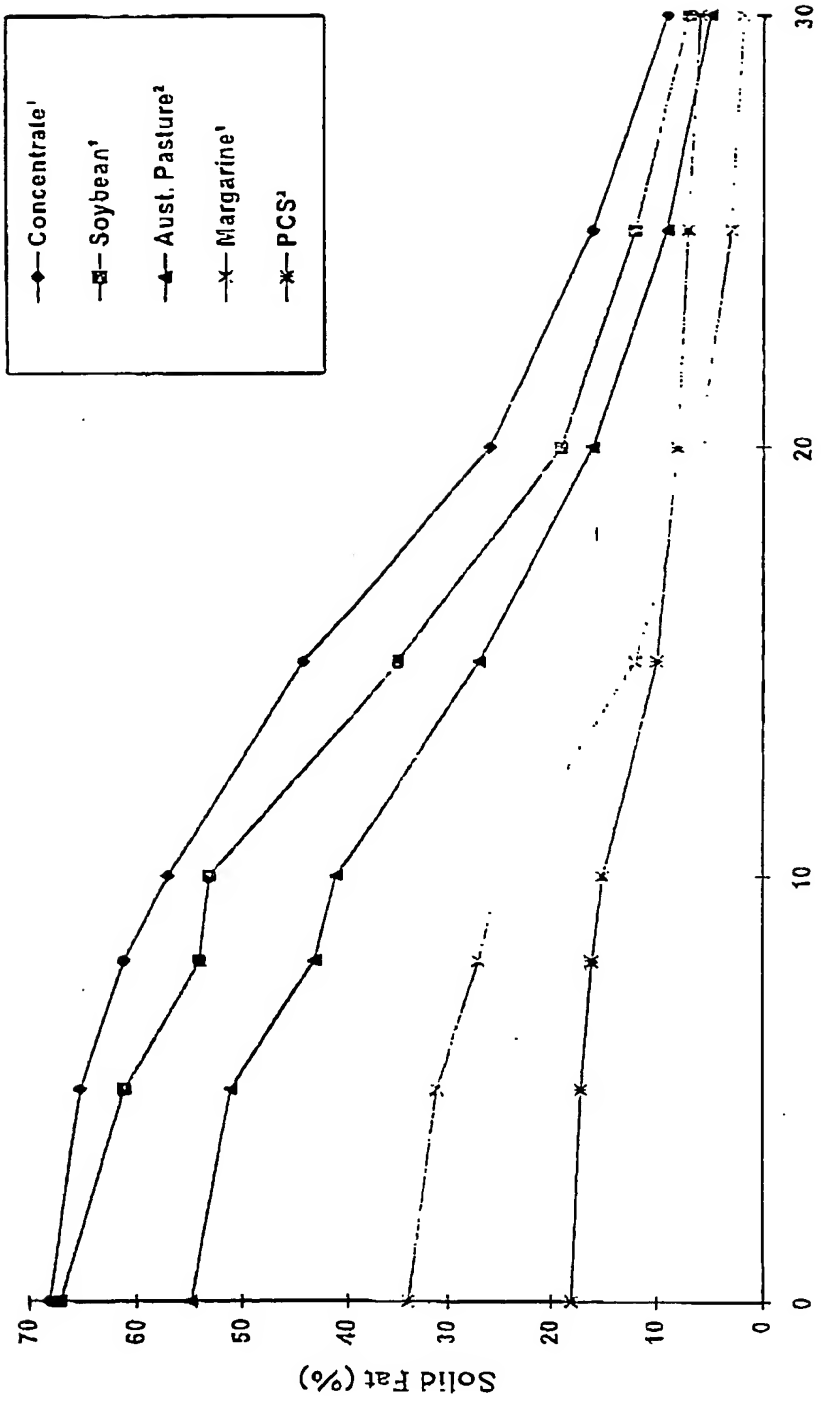
Concentrate¹
Soybean¹
Aust. Pasture²
Margarine¹
PCS²
Solid Fat (%)
70
60
50
40
30
20
10
0
0
10
20
30
Temperature °C

Figure 1

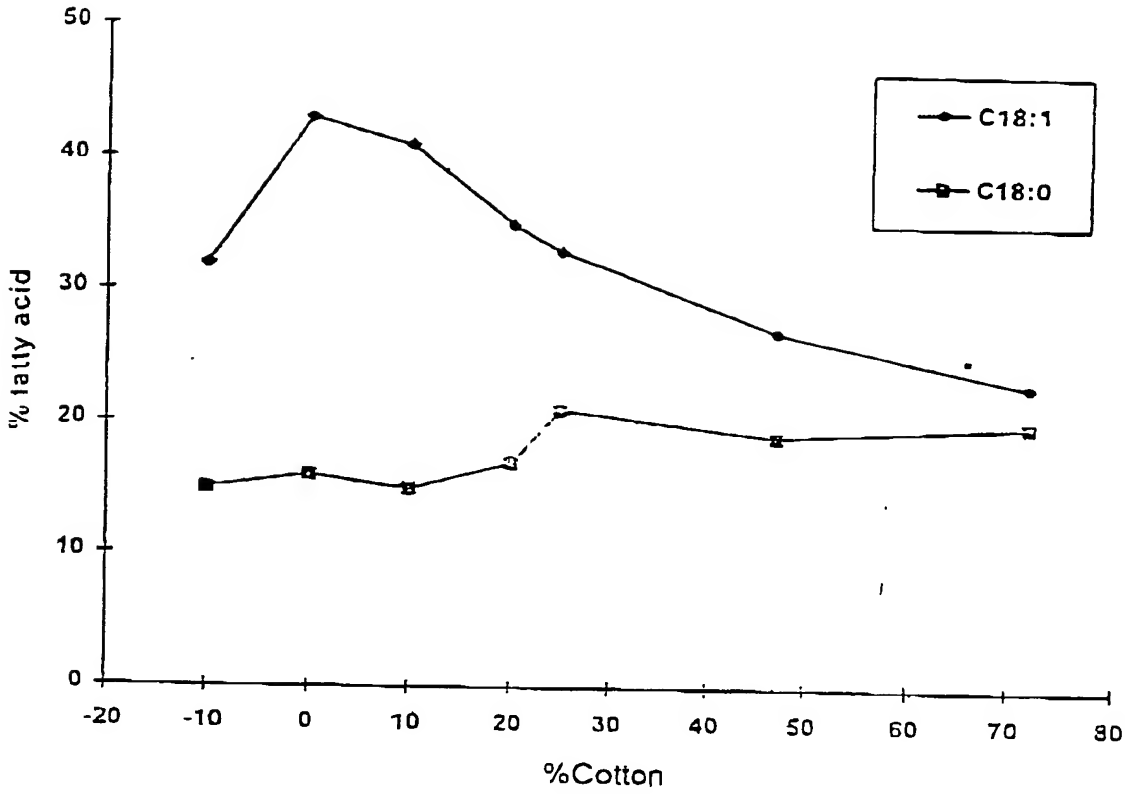
50
40
30
20
10
0
% fatty acid
-20
-10
0
10
20
30
40
50
60
70
80
%Cotton
C18:1
C18:0

Figure 2

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 75709c:ANB	FOR FURTHER ACTION	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416).
International Application No. PCT/AU00/00953	International Filing Date *(day/month/year)* 11 August 2000	Priority Date *(day/month/year)* 13 August 1999

International Patent Classification (IPC) or national classification and IPC

Int. Cl.[7] A23C 9/14 A23D 9/02 A23K 1/00, 1/18

Applicant

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION et al

This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

This REPORT consists of a total of 3 sheets, including this cover sheet.

[X] This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of 3 sheet(s).

This report contains indications relating to the following items:

I	[X]	Basis of the report
II	[ ]	Priority
III	[ ]	Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
IV	[ ]	Lack of unity of invention
V	[X]	Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
VI	[ ]	Certain documents cited
VII	[ ]	Certain defects in the international application
VIII	[ ]	Certain observations on the international application

Date of submission of the demand	Date of completion of the report
6 February 2001	2 July 2001
Name and mailing address of the IPEA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@apaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized Officer TERRY MOORE Telephone No. (02) 6283 2632

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/AU00/00953

1 Basis of the report

With regard to the elements of the international application:*

☐ the international application as originally filed.

☒ the description, pages 1-29, as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☒ the claims, pages , as originally filed,
pages , as amended (together with any statement) under Article 19,
pages , filed with the demand,
pages 30-32, received on 26 June 2001 with the letter of 26 June 2001

☒ the drawings, pages 1/2-2/2, as originally filed,
pages , filed with the demand,
pages , received on with the letter of

☐ the sequence listing part of the description:
pages , as originally filed
pages , filed with the demand
pages , received on with the letter of

With regard to the language, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language which is:

☐ the language of a translation furnished for the purposes of international search (under Rule 23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination (under Rules 55.2 and/or 55.3).

With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

☐ The amendments have resulted in the cancellation of:

☐ the description, pages

☐ the claims, Nos.

☐ the drawings, sheets/fig.

☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

* *Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17)*

** *Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report*

INTERNATIONAL P[redacted]MINARY EXAMINATION REPORT

International application No.
PCT/AU00/00953

V. **Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1 Statement

Novelty (N)	Claims	1-22	YES
	Claims		NO
Inventive step (IS)	Claims	1-22	YES
	Claims		NO
Industrial applicability (IA)	Claims	1-22	YES
	Claims		NO

2 Citations and explanations (Rule 70.7)

The following documents identified in the International Search Report have been considered for the purposes of this report:

D1 US 3 925 560
D2 US 3 966 998
D3 US 4 073 960
D4 US 4 216 234
D5 US 5 143 737
D6 US 5 670 191
D7 US 5 932 257

The invention described in the current application resides in a method for improving the fatty acid profile of milk by feeding a ruminant a supplement comprising a lipid encapsulated in an aldehyde-protected protein complex. The protected complex is formed by treating a protein-lipid emulsion with formaldehyde. The particular lipid sources used and the proportions of respective lipid sources used provide feed supplements with particularly favourable balances of fatty acids and mono, di and tri unsaturated fats.

Novelty (N) and Inventive Step (IS)

None of the citations disclose, or teach toward the specific methods of the claims.

D1 and D3 disclose methods for improving the fatty acid profile of milk by feeding a ruminant a supplement comprising a lipid encapsulated in an aldehyde-protected protein complex. However neither citation discloses milk with C18:1 cis(25-45% w/w), C18:2(4-15%w/w) and C18:3(0.7-9%w/w) or C16:0(25-35%w/w) and C18:0(20-30%w/w) or a method of preparing a feed supplement comprising 70% protected canola and 30% protected soyabean. As such neither citation discloses or teaches toward the methods of the claims.

D4-D7 do not disclose the use of formaldehyde to produce a protected lipid and D5 in particular teaches away from using formaldehyde, citing the potential of toxicity and intestinal damage if agents such as formaldehyde are used. As such none of D4-D7 disclose or teach toward the methods and products defined in the claims.

D2 discloses a feed supplement comprised of lipid encapsulated in an aldehyde protected protein complex. The complex is formed by the addition of formaldehyde to a protein-lipid mix, wherein the mixture is ground under conditions of high temperature and pressure. As such the citation does not disclose emulsification of lipid with protein and consequently does not deprive the claims of either novelty or an inventive step.

Claims

1. A method for altering the fatty acid profile of milk from female ruminant livestock to comprise at least one of the following types and proportions of fatty acids in said milk: C18:1 *cis* (25-45%w/w); C18:2 (4-15%w/w); C18:3 (1-8%w/w); C20:5 and C22:6 omega fatty acid (1-3%w/w), or a combination thereof, wherein said method comprises feeding to the female ruminant livestock, protected lipid such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

2. The method of claim 1, wherein said fatty acid profile comprises at least one of: C18:1 *cis* (30-45%w/w); C18:2 (6-10%w/w); C18:3 (2-4%w/w); C20:5 and C22:6 omega fatty acid (1-2%w/w), or a combination thereof.

3. The method of claim 1 or 2, wherein said C18:2 further includes conjugated isomers (0.5 to 5%w/w).

4. A method for altering the fatty acid profile of milk from female ruminant livestock to have at least one of the following types and/or proportions of fatty acids in said milk: C16:0 *cis* (25-35%w/w), C18:0 (20-30%w/w) and C18:1 (20-25%w/w), wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions and/or types of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

5. The method of claim 4, wherein said fatty acid profile comprises at least one of: C16:0 *cis* (28-35%w/w), C18:0 (25-30%w/w) and C18:1 (22-25%w/w), or a combination thereof.

6. The method according to any one of claims 1-5, wherein about 75 to about 90% of protected lipid is capable of passing undegraded through the rumen.

7. The method according to any one of claims 1-6, wherein the protected lipid is produced by the reaction with between about 2.0 grams and about 2.6 grams of formaldehyde per 100 grams crude portion.

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Received 26 June 2001

8. The method according to any one of claims 1 to 7, wherein the source of lipid is selected from the group consisting of: soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels, linseed, casein, butterfat, yellow grease, lard, fish oils, tung oil, tallow, and oil lipid products derived from oil sources by chemical/biological processes, or a combination thereof.

9. The method according to claim 8, wherein the source of oil lipid product is conjugated linoleic acid or chemical forms thereof.

10. The method according to claim 9, wherein the source of lipid is derived by chemical/biological processes, or a combination thereof.

11. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein available for digestion post-ruminally.

12. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected carbohydrate such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

13. The method according to any one of claims 1 to 10 further comprising simultaneously feeding to the ruminant livestock: (i) protected protein, such that such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

14. A method according to any one of claims 11-13, wherein the source of protein and/or carbohydrate is plant and includes any one of, or a combination of barley, corn, oats, wheat, rice, millet, triticale, rye, and sorghum, soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels and linseed.

15. The method according to any one of claims 1 to 14, further comprising feeding to the ruminant livestock any other source of processed or unprocessed feedstuff.

16. The method according to any one of claims 13 to 15, wherein the protected carbohydrate, protected protein and/or protected lipid is included in the ration at about 10-45% during the lactation phase.

17. Milk fat obtained from a ruminant fed according to the method of any one of claims 1 to 16.

18. The milk fat of claim 17, wherein said milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

19. The milk fat of claim 18, wherein said milk fat is comprised of hard fats.

20. The milk fat of any one of claims 17 to 19, wherein said milk fat is used in the production of milk based products.

21. The milk fat of any one of claims 17 to 20, wherein said milk based products include: milk, butter, cheese, yoghurt, chocolate or infant formula.

AMENDED CLAIMS

[received by the International Bureau on 15 December 2000 (15.12.00); original claims 1 – 10 amended; other claims unchanged (3 pages)]

1. A method for altering the fatty acid profile of milk from female ruminant livestock to comprise at least one of the following types and proportions of fatty acids in said milk: C18:1 *cis* (25-45%w/w); C18:2 (4-15%w/w); C18:3 (1-8%w/w); C20:5 and C22:6 omega fatty acid (1-3%w/w), or a combination thereof, wherein said method comprises feeding to the female ruminant livestock, protected lipid such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

2. The method of claim 1, wherein said fatty acid profile comprises at least one of: C18:1 *cis* (30-45%w/w); C18:2 (6-10%w/w); C18:3 (2-4%w/w); C20:5 and C22:6 omega fatty acid (1-2%w/w), or a combination thereof.

3. The method of claim 1 or 2, wherein said C18:2 further includes conjugated isomers (0.5 to 5%w/w).

4. A method for altering the fatty acid profile of milk from female ruminant livestock to have at least one of the following types and/or proportions of fatty acids in said milk: C16:0 *cis* (25-35%w/w), C18:0 (20-30%w/w) and C18:1 (20-25%w/w), wherein said method comprises feeding to the ruminant livestock, protected lipid having said desired proportions and/or types of fatty acids, such that about 60 to about 90% of said protected lipid is capable of passing through the rumen undigested leaving about 60 to about 90% of said protected lipid available for digestion post-ruminally, and wherein said protected lipid is produced by the emulsification of lipid with protein and the mixing of between about 1.5 grams and about 3 grams of formaldehyde per 100 grams crude portion of said emulsified lipid-protein complex.

5. The method of claim 4, wherein said fatty acid profile comprises at least one of: C16:0 *cis* (28-35%w/w), C18:0 (25-30%w/w) and C18:1 (22-25%w/w), or a combination thereof.

6. The method according to any one of claims 1-5, wherein about 75 to about 90% of protected lipid is capable of passing undegraded through the rumen.

7. The method according to any one of claims 1-6, wherein the protected lipid is produced by the reaction with between about 2.0 grams and about 2.6 grams of formaldehyde per 100 grams crude portion.

8. The method according to any one of claims 1 to 7, wherein the source of lipid is selected from the group consisting of: soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels, linseed, casein, butterfat, yellow grease, lard, fish oils, tung oil, tallow, and oil lipid products derived from oil sources by chemical/biological processes, or a combination thereof.

9. The method according to claim 8, wherein the source of oil lipid product is conjugated linoleic acid or chemical forms thereof.

10. The method according to claim 9, wherein the source of lipid is derived by chemical/biological processes, or a combination thereof.

11. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected protein, such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein available for digestion post-ruminally.

12. The method according to any one of claims 1 to 10, further comprising simultaneously feeding to the ruminant livestock protected carbohydrate such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

13. The method according to any one of claims 1 to 10 further comprising simultaneously feeding to the ruminant livestock: (i) protected protein, such that such that about 60 to about 80% of said protected protein is capable of passing through the rumen undigested leaving about 60 to about 80% of said protected protein is available for digestion post-ruminally, and (ii) protected carbohydrate, such that about 30 to about 80% of said protected carbohydrate is capable of passing through the rumen undigested leaving about 30 to about 80% of said protected carbohydrate available for digestion post-ruminally.

14. A method according to any one of claims 11-13, wherein the source of protein and/or carbohydrate is plant and includes any one of, or a combination of barley, corn, oats, wheat, rice, millet, triticale, rye, and sorghum, soybean, cotton, lupin, peanut, sunflower, sunola, canola, sesame seed, copra and coconut, palm kernels and linseed.

15. The method according to any one of claims 1 to 14, further comprising, feeding to the ruminant livestock any other source of processed or unprocessed feedstuff.

16. The method according to any one of claims 13 to 15, wherein the protected carbohydrate, protected protein and/or protected lipid is included in the ration at about 10-45% during the lactation phase.

17. Milk fat obtained from a ruminant fed according to the method of any one of claims 1 to 16.

18. The milk fat of claim 17, wherein said milk fat is comprised of nutritionally desirable soft fats, including n-3 and n-6 essential fatty acids, conjugated linoleic acid and C_{20} and C_{22} plyenoic fatty acids.

19. The milk fat of claim 18, wherein said milk fat is comprised of hard fats.

20. The milk fat of any one of claims 17 to 19, wherein said milk fat is used in the production of milk based products.

21. The milk fat of any one of claims 17 to 20, wherein said milk based products include: milk, butter, cheese, yoghurt, chocolate or infant formula.

PATENT COOPERATION TREATY

From the INTERNATIONAL BUREAU

PCT

To:
SPRUSON & FERGUSON
GPO Box 3898
Sydney, NSW 2001
AUSTRALIE

NOTICE INFORMING THE APPLICANT OF THE COMMUNICATION OF THE INTERNATIONAL APPLICATION TO THE DESIGNATED OFFICES

(PCT Rule 47.1(c), first sentence)

Date of mailing (day/month/year)	
22 February 2001 (22.02.01)	
Applicant's or agent's file reference	**IMPORTANT NOTICE**
475709C	

International application No.	International filing date (day/month/year)	Priority date (day/month/year)
PCT/AU00/00953	11 August 2000 (11.08.00)	13 August 1999 (13.08.99)

Applicant COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION et al

1. Notice is hereby given that the International Bureau has communicated, as provided in Article 20, the international application to the following designated Offices on the date indicated above as the date of mailing of this Notice:
   AU,KP,KR,US

   In accordance with Rule 47.1(c), third sentence, those Offices will accept the present Notice as conclusive evidence that the communication of the international application has duly taken place on the date of mailing indicated above and no copy of the international application is required to be furnished by the applicant to the designated Office(s).

2. The following designated Offices have waived the requirement for such a communication at this time:
   AE,AG,AL,AM,AP,AT,AZ,BA,BB,BG,BR,BY,BZ,CA,CH,CN,CR,CU,CZ,DE,DK,DM,DZ,EA,EE,EP,ES,FI,GB,GD,GE,GH,GM,HR,HU,ID,IL,IN,IS,JP,KE,KG,KZ,LC,LK,LR,LS,LT,LU,LV,MA,MD,MG,MK,MN,MW,MX,MZ,NO,NZ,OA,PL,PT,RO,RU,SD,SE,SG,SI,SK,SL,TJ,TM,TR,TT,TZ,UA,UG,UZ,VN,YU,
   The communication will be made to those Offices only upon their request. Furthermore, those Offices do not require the applicant to furnish a copy of the international application (Rule 49.1(a-bis)).

3. Enclosed with this Notice is a copy of the international application as published by the International Bureau on
   22 February 2001 (22.02.01) under No. WO 01/11978

REMINDER REGARDING CHAPTER II (Article 31(2)(a) and Rule 54.2)

If the applicant wishes to postpone entry into the national phase until 30 months (or later in some Offices) from the priority date, a demand for international preliminary examination must be filed with the competent International Preliminary Examining Authority before the expiration of 19 months from the priority date.

It is the applicant's sole responsibility to monitor the 19-month time limit.

Note that only an applicant who is a national or resident of a PCT Contracting State which is bound by Chapter II has the right to file a demand for international preliminary examination.

REMINDER REGARDING ENTRY INTO THE NATIONAL PHASE (Article 22 or 39(1))

If the applicant wishes to proceed with the international application in the national phase, he must, within 20 months or 30 months, or later in some Offices, perform the acts referred to therein before each designated or elected Office.

For further important information on the time limits and acts to be performed for entering the national phase, see the Annex to Form PCT/IB/301 (Notification of Receipt of Record Copy) and Volume II of the PCT Applicant's Guide.

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00953

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: A23C 9/14, A23D 9/02, A23K 1/00, 1/18

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: A23C, A23D, A23K and keywords

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPIDS and keywords

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 3925560 A (SCOTT et al) 9 December 1975 Column 2 lines 27-53 and column 7 example 3	1-21
X	US 3966998 A (RAWLINGS et al) 29 June 1976 Abstract and column 10 example 1	1-21
X	US 4073960 A (SCOTT et al) 14 February 1978 Column 2 lines 7-24 and 36-56, claims 1-6	1-21

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 October 2000	16 OCT 2000
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer ANDREW ACHILLEOS Telephone No : (02) 6283 2280

Form PCT/ISA/210 (second sheet) (July 1998)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU00/00953

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4216234 A (RAWLINGS et al) 5 August 1980 Abstract, column7 lines 1-42	1,2 and 17-21
X	US 5143737 A (RICHARDSON, Thomas) 1 September 1992 Abstract, column 11 example 1	1,2 and 17-21
X	US 5670191 A (CUMMINGS et al) 23 September 1997 Column 2 lines 15-25, column 7 example II	1,2 and 17-21
X	US 5932257 A (WRIGHT et al) 3 August 1999 Column 2 line 57 to column 3 line 15	1,2 and 17-21

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/AU00/00953

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
US	4 216 234	AU	21283/77	CA	1086127	GB	1570852
		JP	52-112573				
US	5 143 737	AU	65425/90	WO	91/05482		
US	5 670 191	AU	69699/96	BR	9610710	CA	2229560
		EP	871373	WO	97/11611		
US	5 932 257	AU	30862/97	BR	9709882	CA	2208392
		EP	906031	WO	97/49297		

END OF ANNEX